ROLE OF LIGAMENTOTAXIS IN UNSTABLE DISTAL RADIUS FRACTURES

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M.S. DEGREE EXAMINATION

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CERTIFICATE

This is to certify that **Dr.S.MARIMUTHU**, post graduate student (2007 - 2010) in the Department of Orthopaedics, Kilpauk Medical College, Chennai, has done this dissertation on **'ROLE OF LIGAMENTOTAXIS IN UNSTABLE DISTAL RADIUS FRACTURES'** under my guidance and supervision in partial fulfillment of the regulation laid down by the Tamil Nadu Dr. M.G.R Medical University, Chennai for MS (Orthopaedics) degree examination to be held on March 2010.

Prof.. K.NAGAPPAN
M.S.(ORTHO), D.ORTHO
Professor-HOD,
Department of Orthopaedics
Government Royapettah Hospital
Government Kilpauk Medical College and
Hospital Chennai.

THE DEAN
Government Kilpauk Medical College and Hospital,
Chennai-60010.

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I express my thanks to the PATIENTS for rendering me a chance to make an attempt to lessen their sufferings.

S.MARIMUTHU

CONTENTS

INTRODUCTION

INTRODUCTION

Fractures of the distal radius are among the most common fractures seen in an emergency department

The classic fracture described by SIR ABRAHAM COLLES in 1814 – low energy, extra articular, osteoporotic distal radius fracture – often does well with closed reduction and cast immobilization. High velocity injuries have resulted in severely comminuted and unstable fractures with intra articular components treatment has become increasingly difficult.

Many methods like closed reduction and casting, pins and plaster, percutaneous pinning, external fixation with ligamentotaxis , internal fixation, combined internal and external fixation and arthroscopically assisted reduction have come up.

In a young, active individual with a severely comminuted fracture, acceptable closed reduction may be achieved easily but difficult to maintain. When reduction is lost, a shortened, dorsally angulated carpus with subsequent poor function and early osteoarthritis secondary to articular incongruity may occur.

Percutaneous pinning has all the disadvantages of external fixator like inability to achieve direct reduction, immobilization of radio carpal joint and pin tract infections. It also lacks some of the advantages of external fixators like adjustability, known strength and reusability for a specific patient

Many unstable distal radial fractures are treated by closed reduction and casting with even small degrees of mal alignment adversely affects functional outcome has stimulated interest in external fixation and ligamentotaxis.

External fixation for distal radius fracture relies on the principle of **Ligamentotaxis** in which, a distraction force applied to the carpus aligns the fragments by means of intact ligaments. Distraction assisted reduction and maintenance of distal radius fracture is a widely used and reliable treatment method.

If the principles of ligamentotaxis are applied rationally the factors that cause instability are identified clinically and managed surgically, a satisfactory outcome can be expected.

AIM

AIM

The aim is to study the functional outcome of unstable distal radius fractures managed by ligamentotaxis with external fixation

REVIEW OF LITERATURE

REVIEW OF LITERATURE

HISTORICAL ASPECTS

Fractures of the distal end of the radius has been recognized from the ancient times but mostly recognized as dislocations of wrist.

SIR ABRAHAM COLLES[8], an Ireland surgeon, classically described the fracture in the Edinburgh Medical Surgical journal in 1814. He classically described the ‘dinner fork deformity’ and the six displacements, dorsal displacement, dorsal angulation, lateral displacement, lateral angulation, impaction and supination. He also described the management of the fracture by closed reduction and cast application.

The first description of this fracture has been attributed to POUTEAU,[33] the French surgeon. He described the fracture in 1783. In some parts of the world the fracture of the distal radius is called Pouteau’s fracture. SIR ASTLEY COOPER produced the first book to describe wrist injuries – “DISLOCATIONS AND FRACTURES OF JOINTS “in 1822.

BARTON[4] in 1838 described a fracture dislocation or subluxation in which the rim of the distal radius is displaced dorsally or volarly along with the hand and carpus.

SMITH[41] in 1854 described a volar angulated fracture of the distal radius with a ‘Garden Spade’ deformity. In this reverse Colle’s fracture the hand and wrist are displaced volarly with respect to forearm. This fracture pattern included both extra articular as well as intra articular involvement and also formed part of the fracture dislocation of the wrist.

J.H.MAYER described experimental studies on Colle’s fracture and published in British Journal of surgery. SIR REGINAL WATSON – JONES described the fracture in his book “FRACTURES AND JOINT INJURIES” in 1941.

The advent of Radiology and increased incidence of high velocity injuries and intra articular involvement and more proportion of young people getting involved resulted in an unstable radius fracture which was no longer simple to treat and maintenance of reduction of the fracture became increasingly difficult. There were also developments in orthopedic surgery like open reduction, internal fixation, plate osteosynthesis and external fixators which were applied to the treatment of this fracture.

ANDERSON AND O'NEIL used external fixation for the management of these fracture and showed good results. In 1950, SIR JOHN CHARNLEY in his book "CLOSED TREATMENT OF FRACTURE" described the fracture and gave a mechanical analogy.

In 1951 –GARTLAND AND WERLEY[16] published their system of evaluation of Colle's fracture in the functional demrit system in JBJS 1951. This system allows for comparison of results among several studies and different methods of fracture management.

In 1952 DEPALMA[11] used distraction for treatment of the distal radius fractures by his method of ulnar pinning. In 1953 BACRON RW and KURTAZKE J.F[3] studied colle's fracture in 2000 patients from NewYork Workmen's compensation.

LIDSTROM[26] studied the end results of Colles's fracture and published his classification which was based on the radiographic of the fracture. COLE & OBLETEZ popularized the pins and plaster method of treatment in 1966.

In 1967 FRYKMAN'S[14] classification was introduced. It involves radio carpal joint, radio ulnar joint and ulnar styloid process fracture.

In 1975 SARMIENTO introduced functional cast bracing to distal radius fractures and immobilized the patient in supination. He modified the GARTLAND & WERLEY system of evaluation. The AO – ASIF group developed techniques of open reduction and internal fixation and external fixation. They applied their principles to distal radius fractures like k wire pinning, plating and external fixators. They introduced AO minifixator for the distal radius.

CHARLES P. MELONE'S[29] work is based on the intra articular components of the fracture. He classified the intra articular fractures into four types comprising the four basic components, the shaft, radial styloid, dorsal medial and palmar medial components in 1993 the "DIE PUNCH FRACTURE" of the lunate fossa.

FERNANDEZ[13] et al studied articular fracture of distal radius treated with external fixators. He introduced a classification based on compression, bending, shear, with intra articular 3 – part components. MULLER in 1987 introduced the AO – ASIF classification for distal radius fractures.

In 1987 CLYBURN treated patients with dynamic external fixators and showed good results. HORESH 1991 published a prospective study of comminuted distal radius fractures treated with AO – mini external fixators.

KAPANDJI[24] in 1987 published the results of intra focal pinning technique. JOHN RAYHACK introduced his technique of percutaneous pinning using K wires through subarticular surface of the distal radius to the intact ulna. Rayhack 1993 proposed UNIVERSAL CLASSIFICATION system modified from that of gartland & werley which simplifies the management.

WILLIAM P. COONEY, R.L.LINSCHEID et al studied distal radius fractures and drew attention to the complications, bone grafting, carpal instability and the triangular fibrocartilage injuries associated with the distal radius fractures

In 1993 JOHN AGEE[1] described an external fixator with MULTIPLANAR LIGAMENTOTAXIS the WRISTJACK, based on the pathomechanics of injury.

PENNING D. in 1995 introduced his fixator and transarticular and extra articular external fixation with early motion in distal radius fractures.

New developments in external fixator frames, combination and multiple modalities like combined internal and external fixation for highly unstable fractures, addition of bone grafting, biodegradable cementing and newer information on muscle – tendon physiology, wrist ligaments and 3 – dimensional motion studies will increase the understanding the surgical anatomy and accurate anatomic reduction of the fracture.

Demography

Incidence

The distal radius fracture is the most common forearm fracture. McMurthy et al reported that distal radius fractures account for one sixth of all fractures seen in any emergency department.

Age

A bimodal age distribution has been documented. Peaks occur at ages between 5-14 years and at ages between 60-69 years. The first peak is due to increased **physical activity** seen in adolescents and second peak is due to **osteoporosis** of old age.

The majority of the fracture in the elderly are extra articular, whereas the incidence of intra articular fractures are much higher in the young.

Sex

Most distal radial fractures occur in postmenopausal women. So in elders, the male to female ratio is 1: 4. However in adolescent boys and girls the ratio is 3: 1 because of their level of sports involvement.

Risk Factors

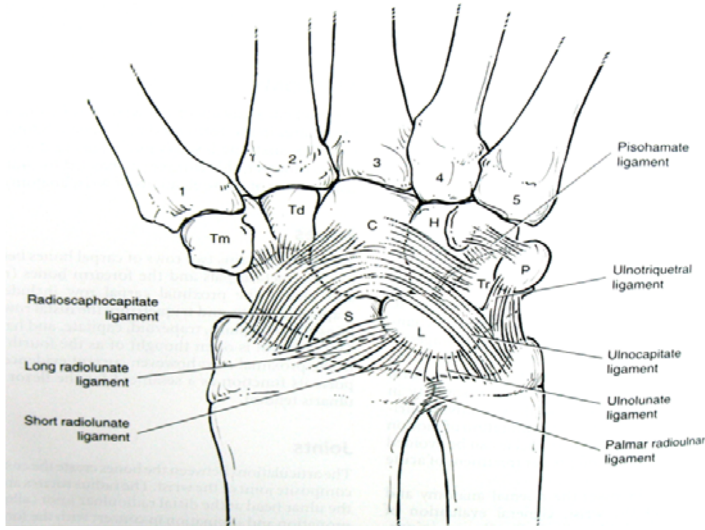
Decreased bone mineral density, female gender and early menopause have all been shown to be risk factors for fractures of distal radius.

Anatomy

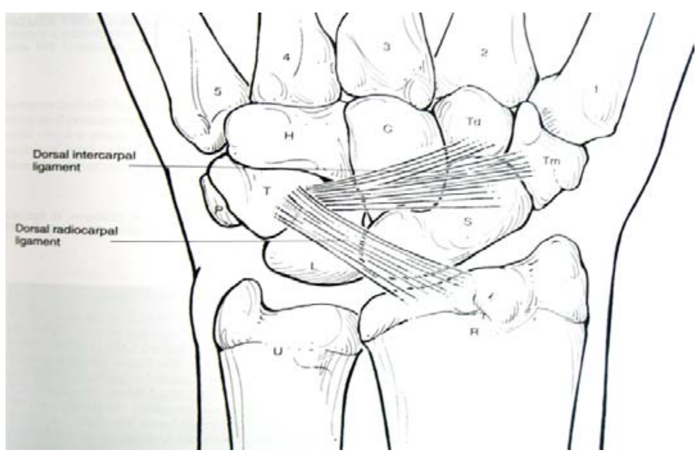
The distal radius functions as an articular plateau upon which the carpus rests and from which the radially based supporting ligaments of the wrist arise. The hand and radius as a unit articulate with and rotate about the ulnar head via the sigmoid notch of the radius.

The distal radius has three concave articular surfaces – the scaphoid fossa, the lunate fossa and the sigmoid notch – for articulation with scaphoid, lunate and ulnar head respectively.

VOLAR LIGAMENTS



DORSAL LIGAMENTS



Ligaments

The distal radius is connected to carpal bones and ulnar head through a number of ligaments which play vital role in stability, load transfer and wrist kinematics.

Extrinsic Ligaments

They connect carpal bones to forearm bones.

Palmar Radio Carpal ligaments:

1) Radio Scapho Capitate ligament-

   radial component of arcuate complex

2) Long Radio Lunate ligament
3) Short Radio Lunate ligament
4) Radio Scapho Lunate ligament

Dorsal Radio Carpal ligaments:

1) Radio Scaphoid ligament
2) Radio Triquetral ligament
3) Dorsal Intercarpal ligament

Ulno Carpal ligaments:

1) Ulno Capitate ligament-

ulnar component of cruciate ligament

2) Ulno Triquetral ligament

3) Ulno Lunate ligament

Distal Radio Ulnar ligaments:

1) Triangular Fibro Cartilage Complex

It is the most important stabilizer of Distal Radio Ulnar Joint. It arises along the entire ulnar aspect of the distal articular surface of the radius, at the distal margin of the sigmoid notch. It is inserted into base of ulnar styloid, lunate, triquetrum, hamate and finally at the base of fifth metacarpal. The central 80% of Triangular Fibro Cartilage Complex is avascular

2) Dorsal and Volar RadioUlnar ligaments.

Intrinsic Ligaments

They interconnect carpal bones. Important are Scapho Lunate interosseous ligament and Luno Triquetral interosseous ligament.

Kinematics

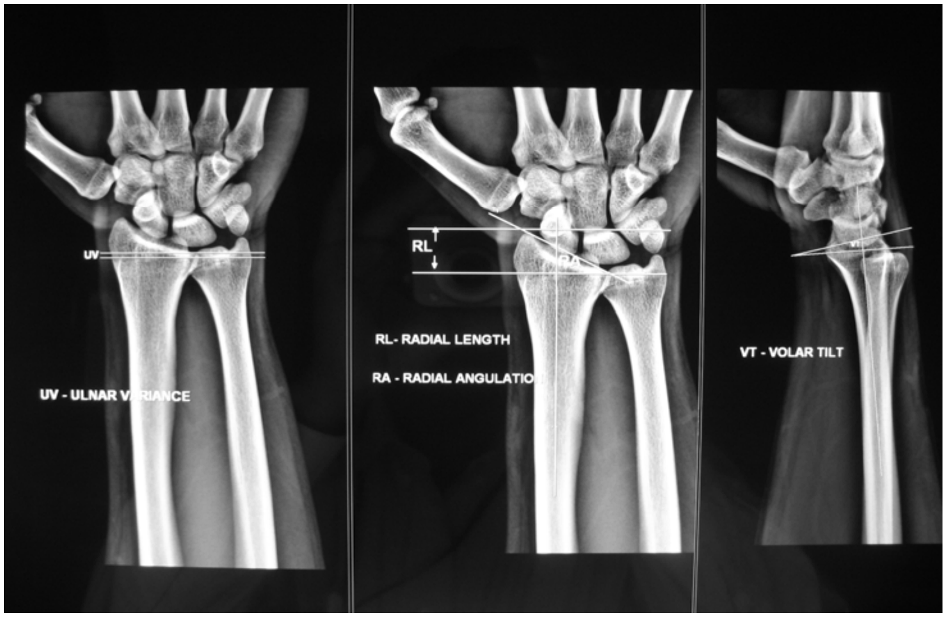
The motors of the wrist are attached to the metacarpals. Capitate is the centre of rotation of wrist joint.

Wrist flexion – extension occur equally through radio carpal and midcarpal joints. Radial – ulnar deviations occur 60% through midcarpal joint and 40% through radio carpal joint.

Normal range of movements:

Flexion	0 to 70-90º
Extension	0 to 70-90º
Radial deviation	0 to 15-25º
Ulnar deviation	0 to 25-35º
Supination	0 to 70-90º
Pronation	0 to 70-90º

Normally, 82% of the axial load at the wrist is borne by Radius and 18% by Ulna.


UV
UV - ULNAR VARIANCE
RL
RA
RL- RADIAL LENGTH
RA - RADIAL ANGULATIO
VT - VOLAR TILT

Radiological anatomy

Radial length or height

It is the measurement along the longitudinal radial axis between tip of radial styloid and articular surface of ulna in postero-anterior view. This length is influenced by radial inclination and ulnar variance. Normal radial length is 11-12mm.

Radial angulation or inclination

In postero-anterior view, it is the angle between plane perpendicular to longitudinal radial axis and a line drawn touching tip of radial styloid and radial articular surface. Normal is 22 - 23^{o}.

Ulnar variance

In postero-anterior view, it is the difference between articular surfaces of radius and ulna. It may be neutral, positive or negative. Positive ulnar variance means loss of radial height. Normal is 0.9 - 1mm.

Palmar tilt

In lateral view, it is measured by the angle between plane of distal articular surface and the plane perpendicular to longitudinal axis of radius. Normal is 11 - 12^{o}.

In a suspected case of fracture of distal radius, standard postero anterior and lateral views are taken.

A fall on the outstretched hand is the most common mechanism for causing distal radius fracture. The fracture pattern can be based on the following variables.

1) Velocity
2) Position of hand and wrist at impact
3) Degree of rotation of forearm
4) The individual's bone quality and density

In a forward fall in which the forearm is pronated and the hand and wrist extended, the body weight of the patient is transmitted along the axis of radius resulting in bending forces at the level of metaphyseal bone. The volar cortex fails under tensile stress and the dorsal cortex fails from compressive forces at impact. Impaction and collapse of the cancellous bone of the metaphysis also occur due to penetration of the harder and stiffer cortical bone at the proximal diaphyseal section. With dorsally displaced fractures, the distal fragment supinates with respect to the radial diaphysis.

Ulnar styloid fractures have been identified in approximately 50-60% of distal radius fractures. The Triangular Fibro Cartilage can be injured with or without an associated fracture of ulnar styloid.

CLASSIFICATION

CLASSIFICATION OF DISTAL RADIAL FRACTURES

A useful classification system for radius fracture must consider the severity of the bone lesions and serve as a basis of treatment and for evaluation of outcome – MAURICE MULLER.

BURSTEIN suggested that a classification to be functional should have inter – observer reliability, repeatability and intra- observer reliability.

Systems of Classification

BASED ON EXTENT OF COMMINUTION

Gartland & Werley

Older

Jenkins

BASED ON RADIOGRAPHIC APPERANCES

Lidstrom classification

Sarmiento

AO-ASIF classification

Universal classification

BASED ON ARTICULAR INVOLVEMENT

Frykman’s classification

McMurtry and Jupiter

Melone’s classification

Mayo’s classification

BASED ON MECHANISM OF INJURY

Castaing

Fernandez

GARTLAND AND WERLEY SYSTEM OF CLASSIFICATION

GROUP 1:

Simple colle’s fracture with no involvement of the radial articular surface

GROUP 2:

Comminuted Colle’s fracture with involvement of the radial articular surface

GROUP 3:

Comminuted Colle’s fracture with involvement of the radial articular surface with displacement of the fragments

GROUP 4:

Extra articular , undisplaced.

LIDSTROM CLASSIFICATION[26]

This classification is based on radiographic appearance and extent of comminution of the fracture

GROUP I:

Minimal displacement

GROUP II:

Fractures with posterior displacement

GROUP II A:

Extra articular , dorsal angulation

GROUP II B:

Fracture with merely dorsal angulation involving the joint but without Comminution of the articular surface.

GROUP II C:

Fracture with complete displacement not involving the joint surface.

GROUP II D:

Fracture with complete displacement but without comminution of the articular Surface

GROUP II E:

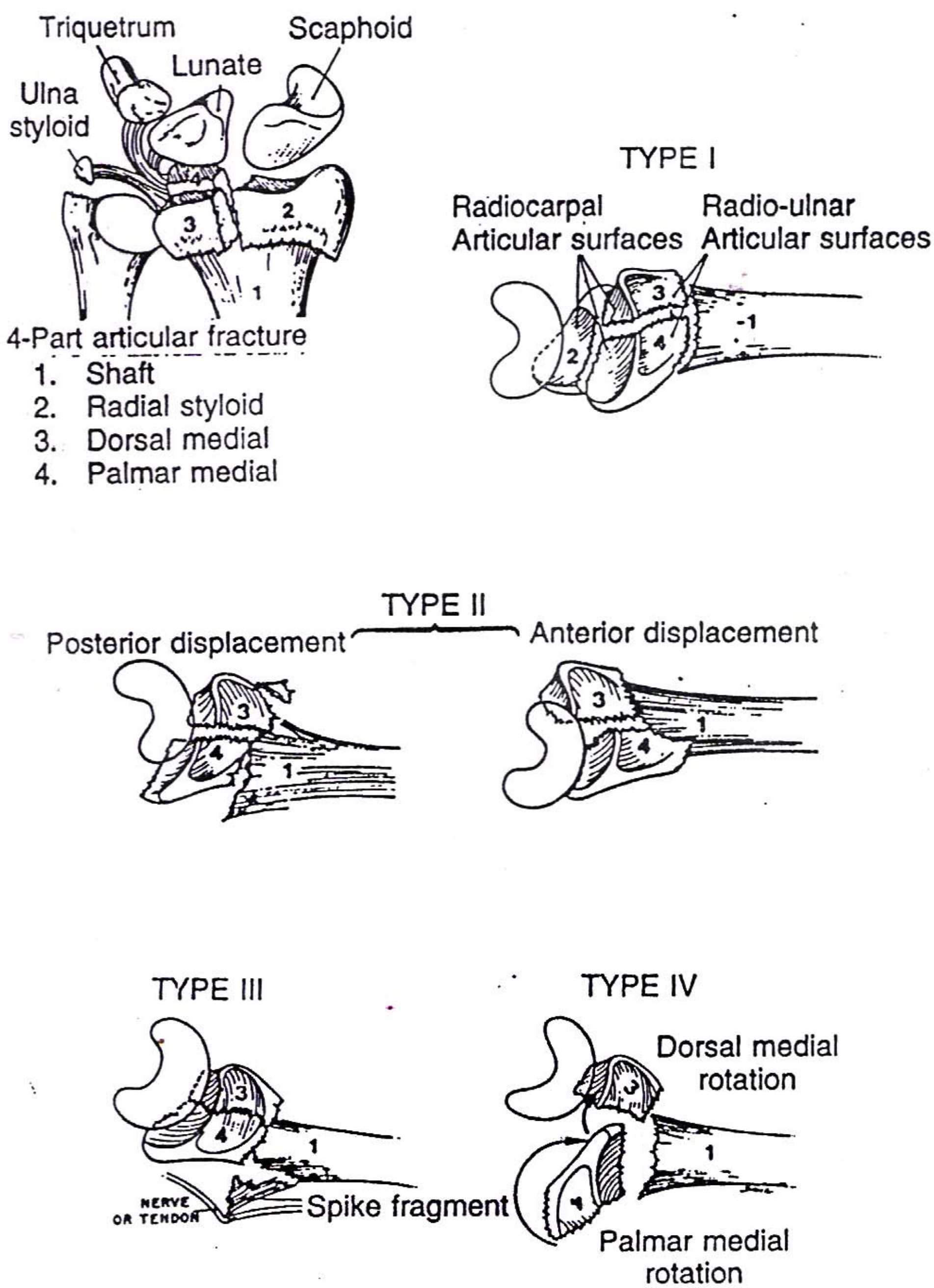
Fracture with complete displacement and comminution at the joint Surface

GROUP III:

Fracture with volar displacement.

CHARLES P.MELONE in 1987 , classified the intra articular fracture based on consistent fracture patterns resulting from the characteristic die-punch mechanism of injury. The fractures generally comprise four basic components. The key medial fragments, owing to their pivotal position, are the cornerstones of both the radiocarpal and distal radio ulnar joints, and have been termed the medial complex Displacement of this is the basis for categorization of the articular fracture into specific types.

MELONE'S INTRA-ARTICULAR FRACTURE CLASSIFICATION



Melone[29] Classification of Intra – Articular Fractures

TYPE I:

Stable fracture : non displaced or variable displacement of the medial complex as a unit; no comminution; stable after closed reduction

TYPE II:

Unstable "die –punch": moderate or severe displacement of the medial complex as a unit, with comminution of both anterior and posterior cortices separation of the medial complex from the styloid fragment; radialshortening > 5 – 10 mm; considerable angulation usually exceeding 20 degrees

TYPE III:

"spike " fracture : unstable; displacement of the medial complex as a unit as well as displacement of an additional spike fragment from the comminuted radial shaft.

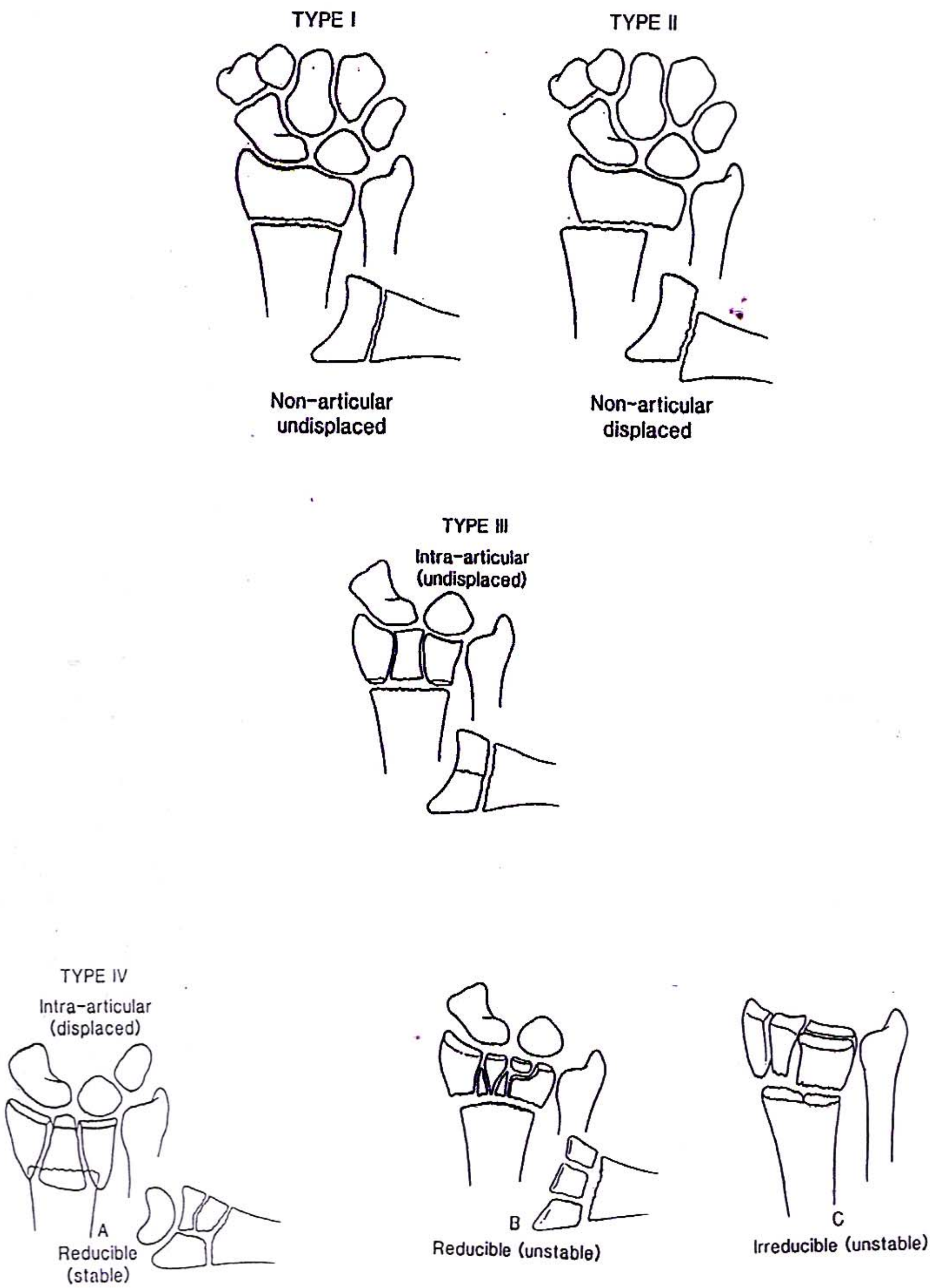
TYPE IV:

Split fracture: unstable; medial complex severely comminuted, with wide separtion and / or rotation of the distal and palmar fragments

TYPE V:

Explosion injuries.

UNIVERSAL CLASSIFICATION



RAYHACK simplifies the criteria by classifying the fracture's inherent stability while reduced.

UNIVERSAL CLASSIFICATION

TYPE I:

Nonarticular	-	Non displaced

TYPE II:

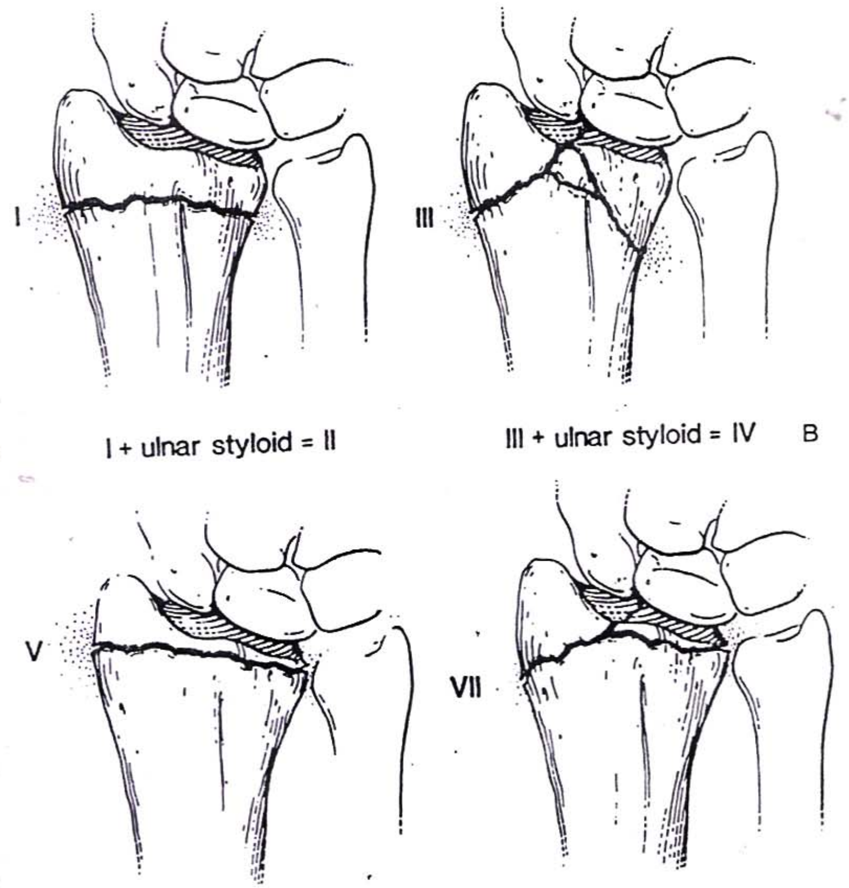
Nonarticular	-	displaced
A. reducible *	-	stable
B. reducible*	-	unstable

TYPE III:

Articular	-	Non displaced
A. Reducible *	-	stable
B. Reducible *	-	Unstable
C. Irreducible*		

*Treatment by ligamentotaxis.

FRYKMAN'S CLASSIFICATION



A I + ulnar styloid = II

III + ulnar styloid = IV B

C V + ulnar styloid = VI

VII + ulnar styloid = VIII D

Frykman's[14] Classification

Frykman's classification is commonly used and easy to apply. It considers involvement of raidocarpal, radio unlar joint and ulnar styloid fracture. But the classification does not include the direction of initial displacement dorsal comminution and shortening of distal fragment and hence is less useful in evaluating the outcome of treatment

Frykman's Classification

TYPE I:

Extra articular fracture

TYPE II:

Extra articular fracture with ulnar styloid fracture

TYPE III:

Radio carpal articular involvement

TYPE IV:

Radio carpal involvement with ulnar styloid fracture

TYPE V:

Radio ulnar involvement

TYPE VI:

Radio ulnar involvement with ulnar styloid fracture

TYPE VII:

Radio ulnar and radio carpal involvement

TYPE VIII:

Radio ulnar and radio carpal involvement with ulnar styloid fracture.

Fernandez and Geissler system consists of type1 through type 5.

Type 1 – bending fractures of metaphysis.

Type 2 – shearing fracture of joint surface

Type 3 – compression fracture of joint surface

Type 4 – avulsion fracture and radio carpal dislocation

Type 5 – combination types 1 to 4.

This system also provides associated injuries of DRUJ.

Type 1 represents stable DRUJ

Type 2 represents unstable DRUJ

Type 3 represents potentially unstable DRUJ.

Fernandez system also dictates treatment for individual type.

The AO system

1. Identifies displacement as well as extent of comminution present.

2. Provides for a system to document any ulnar sided involvement and

3. Subclasifies volar distal radius fractures more accurately.

This system consists of types A, B and C. Type A is extra articular fracture and further subdivided in to A1, A2 and A3 based on comminution.

Type A – Extra articular fracture.

- A1 – Extra articular ulnar fracture
- A1.1 – styloid process fracture
- A1.2 – simple fracture of metaphysis
- A1.3 – multifragmentary metaphyseal fracture
- A2 – Simple or impacted extra articular radius fracture.
- A2.1 – Undisplaced
- A2.2 – with dorsal tilting
- A2.3 – with anterior tilting

- ❖ A3 – Simple or impacted multi fragment extra articular fracture.
- ❖ A3.1 – with axial impaction and shortening
- ❖ A3.2 – with a wedge
- ❖ A3.3 - complex

Type B – Partially articular fracture.

- ❖ B1 - sagittal rim fracture
- ❖ B1.1 – simple lateral
- ❖ B1.2 – multifragmentary lateral
- ❖ B1.3 – medial

B2 – dorsal rim fracture.

- ❖ B2.1 – simple
- ❖ B2.2 – with an additional lateral sagittal fracture.
- ❖ B2.3 – with dorsal dislocation of the carpus.

B3 – volar rim fracture.

- ❖ B3.1 – simple with a small fragment
- ❖ B3.2 – simple with a large fragment
- ❖ B3.3 – multi fragmentary

Type C – Intra articular fracture.

- C1 – simple articular, simple metaphyseal fracture
- C1.1 – with a postero medial articular fragment
- C1.2 – articular fracture line in sagittal plane
- C1.3 - articular fracture line in frontal plane.

- C2 – simple articular, multi fragment metaphyseal fracture.
- C2.1 - articular fracture line in sagittal plane.
- C2.2 - articular fracture line in frontal plane.
- C2.3 – metaphyseal fracture extends into the diaphysis

- C3 – complete articular multi fragment metaphyseal fractures.
- C3.1- metaphyseal simple
- C3.2 – metaphyseal fracture also multi fragmentary
- C3.3 – multi fragmentary metaphyseal fracture extending into the diaphysis.

The complete AO classification when applied in a distal radius fracture shows poor interobserver reliability and the main group are sufficient to be used reliably to grade the severity of the lesion.

No classification system is universally accepted or capable of identifying fractures at risk of malunion. The key principle is that one should be able to define the fractures when examining the radiographs and assess inherent biomechanical stability. The stability of the fracture pattern will dictate treatment.

Indications for External Fixation And Ligamentotaxis

The use of external fixation and ligamentotaxis is indicated in the distal radius fractures in the following circumstances.

- Displaced mechanically unstable fractures in whom achieving and maintaining reduction is difficult
- Frykman's types VII and VIII are absolute indications while other types with features of instability are also amenable to external fixation and ligamentotaxis
- Secondary to loss of reduction in closed treatment
- Bilateral upper extremity injury
- Open fractures
- Young patient with high velocity injuries
- Dorsal angulation more than 20 degrees
- Dorsal communication more than 50% of width
- Radial shortening of more than 5mm

Advantages of External Fixation

External fixators have many advantages in the management of distal radius fractures They are:

1. Relatively easy to use
2. Adaptable
3. Relieves pain
4. Well accepted by the patient
5. It is highly versatile, provides access for soft tissue. Can be converted to other forms and modalities of treatment like bone grafting and pinning
6. Minor post operative adjustments are possible

Disadvantages

While there are many advantages to the use of the external fixators, there are few disadvantages also. From the reduction point of view, the external fixators cannot effectively correct the dorsal tilt. Over distraction of the distal radial fracture may lead to dorsal tilt, stiffness and carpal instability.

Unstable Fractures

In treating distal radial fractures the treatment decision is based on the extent of potential instability. Instability is predicted by both radiological and clinical parameters. They are:

1. Initial dorsal angulation > 20 degress.
2. Radial shortening 5 mm or more
3. Dorsal cortex comminution > 50 % of the diameter of radius in lateral view.
4. Radial displacement > 4 – 6 mm
5. Intra articular fractures.
6. Secondary instability – failed closed reduction
7. Residual dorsal angulation > 10 degrees
8. Residual shortening > 5 mm.

Complications:

The reported complication rates of distal radius fracture in the literature vary from 6% to 80%. Complication may occur from the fracture or its treatment.

Immediate complications:

1) Nerve injuries - commonly Median nerve.
2) Acute Carpal Tunnel Syndrome.
3) Compartment syndrome.
4) Open fractures
5) Skin injury during manipulation in the elderly.
6) Missed associated injuries.

Early complications (less than six weeks):

1) Loss of reduction
2) Plaster related complications
3) Infection in open fractures and operated cases.
4) Carpal Tunnel Syndrome.
5) Tendon rupture.

Late complications (more than six weeks):

1) Carpal Tunnel Syndrome.
2) Reflex Sympathetic Dystrophy
3) Malunion
4) Delayed union
5) Post traumatic arthritis

6) Tendon rupture and adhesions.

7) Dupuytren’s contracture.

Complications related to External Fixation:

1) Pin site infection

2) Pin loosening

3) Radial sensory nerve injury

4) Over distraction which may lead to stiffness, Pain and iatrogenic nonunion.

MATERIALS AND METHODS

MATERIALS AND METHODS

This study was conducted in Government Royapettah Hospital for 2007 – 2009. Patients with unstable distal radius fractures were selected and treated with external fixator based on the principle of ligamentotaxis.

Most of the cases resulted from high velocity injuries and fall on outstretched hand. The cases presented with swelling, pain of the wrist and painful movements.

All the patients were evaluated with X rays of the wrist postero – anterior view and lateral view. The patients for whom external fixation and ligamentotaxis was planned were temporarily given below elbow plaster splint to relieve pain and limb elevated for edema to subside. Injection tetanus toxoid was given to all the patients.

Most of the patients were operated on the day of admission in the emergency operation theater and few cases were delayed due to the medical conditions and in cases of gross edema to subside. All the patients were given per-operative antibiotics.

Patients with

1) Stable fracture with dorsal angulation < 20º
2) Previous ipsilateral or contralateral fracture of wrist.
3) Patients with dementia or psychiatric illness
4) Age less than 20 years were excluded from study.

On presentation, the following were evaluated.

1) Condition of skin
2) Condition of local nerve function
3) Condition of vascularity
4) Tendon function
5) Function of elbow, shoulder and fingers
6) Forearm rotation
7) General medical condition.

Preoperative Radiological Assesssment

Preoperative radiographs of affected and unaffected distal radius were taken. Postero anterior and lateral X rays were taken. Following observations were made.

1) Radial length

2) Dorsal angulation

3) Radial inclination

4) Ulnar variance

5) Dorsal comminution

6) Step

7) Gap

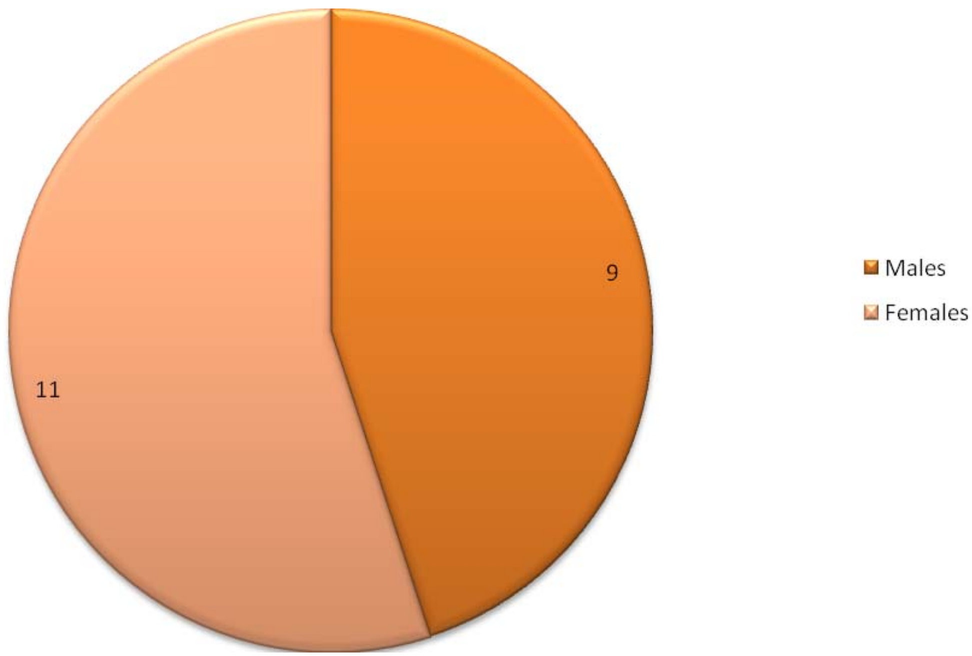
In this study, we followed Frykman’s classification to classify the fractures. Unstable fractures were identified and managed with external fixator & ligamentotaxis.

Total number of cases	20
Bilateral	0
Total number of wrists	20
Compound fractures	3

SEX

Males	9
Females	11

SEX DISTRIBUTION



AGE (20 – 65 YEARS)

Age	Male	Female
20-30	3	2
31-40	0	1
41-50	3	3
51-60	2	2
61-70	1	3

SIDE OF INJURY

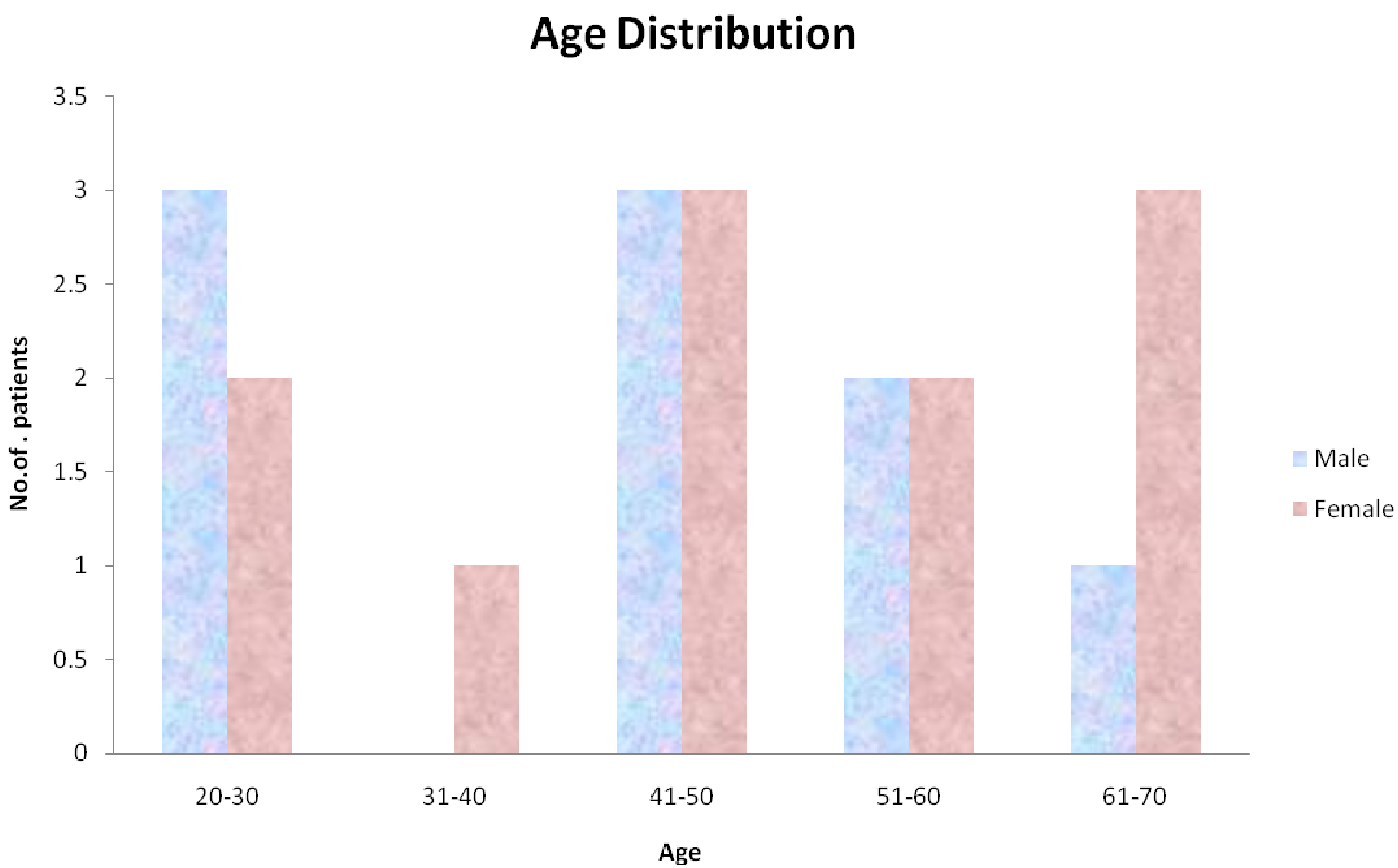
Right	13
Left	7

MODE OF INJURY

Road traffic accidents	10
Fall on out stretched hand	10

ANAESTHESIA

Axillary block	12
Supraclavicular block	7
Intra venous anaesthesia	1


Age Distribution
3.5
3
2.5
2
1.5
1
0.5
0
No.of . patients
20-30
31-40
41-50
51-60
61-70
Age
Male
Female

ASSOCIATED INJURIES

Fracture shaft of humerus	1
Fracture distal ulna	2

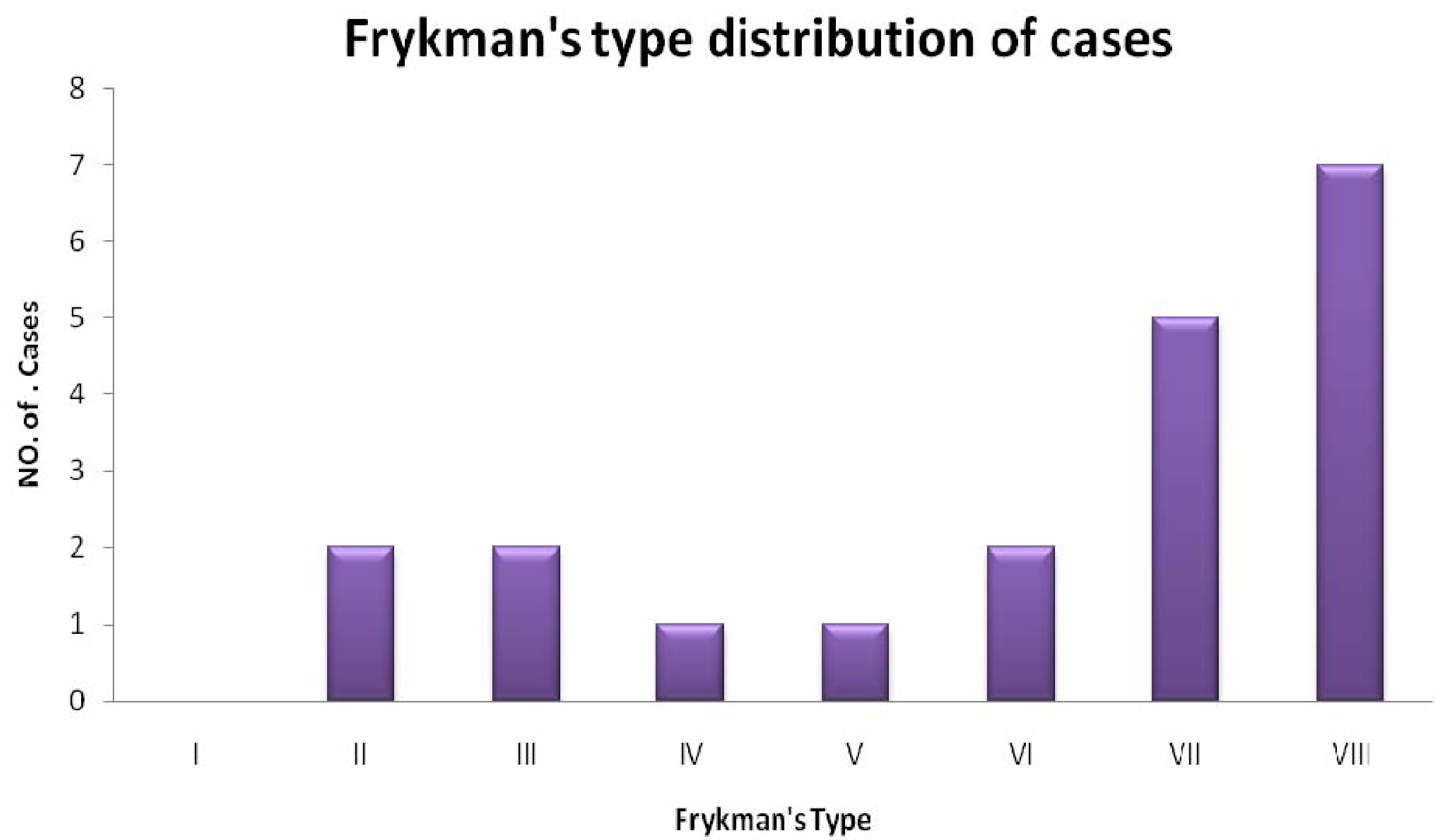
ADDITIONAL PROCEDURES

K wire fixation	5
Bone grafting	0
Palmar supportive slab	3

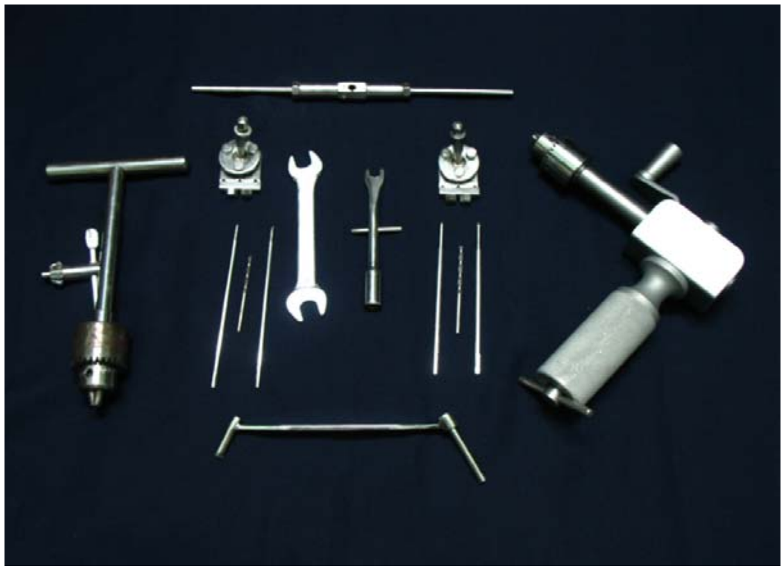
FRYKMAN’S TYPE DISTRIBUTION

TYPE	**NO. OF CASES**
I	0
II	2
III	2
IV	1
V	1
VI	2
VII	5
VIII	7

In external fixation (ligamentotaxis) group, the fracture reduction was first achieved under anaesthesia by the same method as for closed reduction group.


Frykman's type distribution of cases
NO. of . Cases
0
1
2
3
4
5
6
7
8
I
II
III
IV
V
VI
VII
VIII
Frykman's Type

INSTRUMENTS FOR EXTERNAL FIXATION



Then, the limb was painted and draped. The metacarpal pins were applied first. 1cm incision made over metaphyseal flare of second metacarpal. Blunt dissection was carried out avoiding injury of superficial radial nerve and first dorsal interosseous muscle.

Second metacarpal was drilled with 2.0mm drill bit while protecting soft tissues using drill guide. Then 2.5mm × 100mm schanz pin inserted. A second pin was applied distally by same method.

Radial pins were applied 10cm proximal to radial styloid. 1 cm incision was made along the line joining lateral condyle Humerus and Lister's tubercle of distal Radius, blunt dissection carried out to reach radial shaft avoiding injury to radial sensory nerve and extensor tendons.

Radial shaft was drilled with 2.5mm drill bit while protecting soft tissues with drill guide. Drilling was done in such a way that pins were placed on radial side and 30º dorsally. A 3.5mm × 100mm schanz pin inserted. Second radial pin was applied distal to first pin by same method.

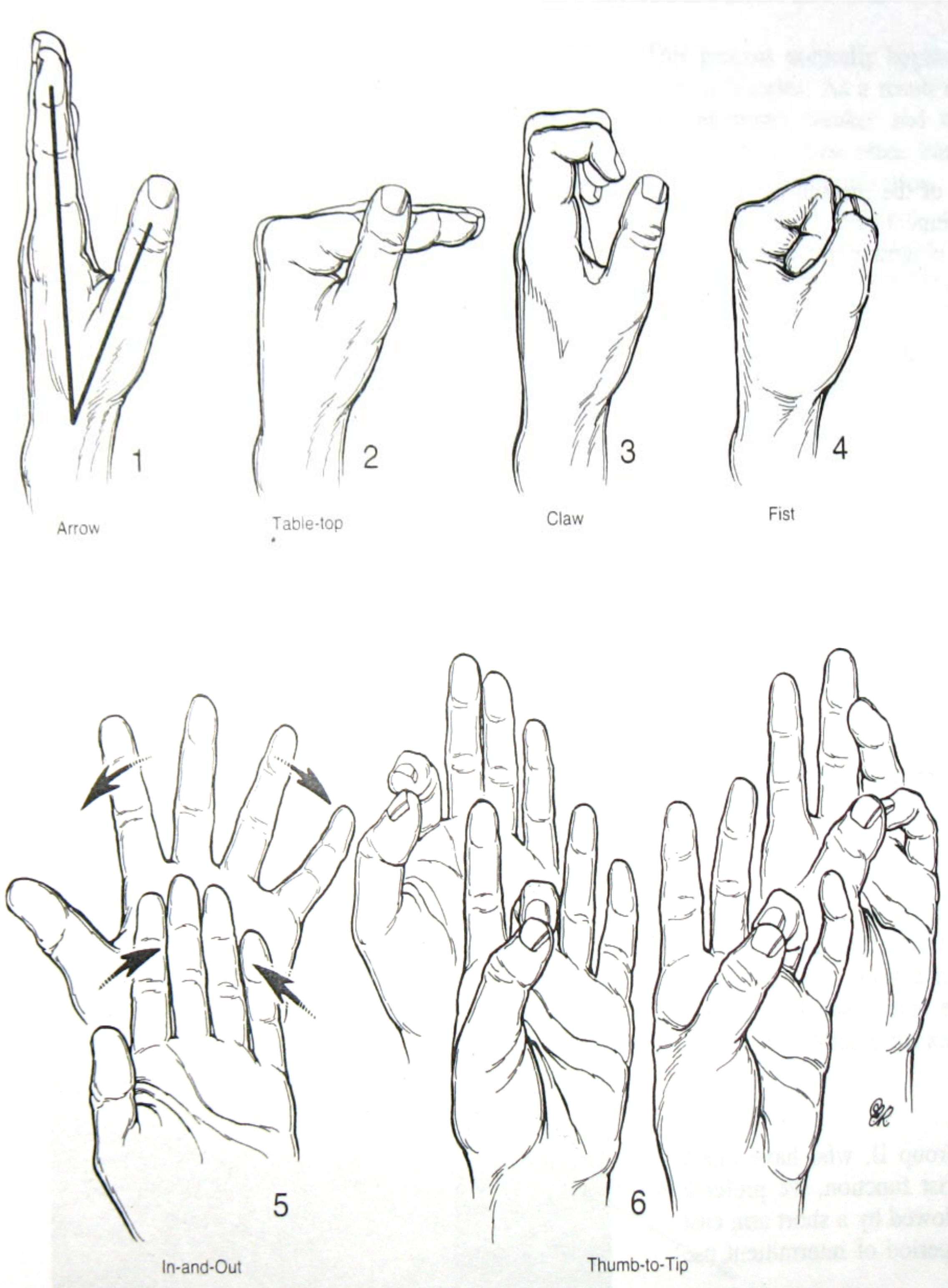
The metacarpal pins were connected to multiaxial ball clamp and radial pins were connected to another multiaxial ball clamp. The ball clamps were connected to distraction rod. Check X rays taken and fine tuning of distraction done. No more than 2 - 3mm distraction was applied over radio carpal joint.

Postoperatively patients were encouraged to do active finger movements from day one. Six pack exercises were taught. Limb was kept elevated for 24 – 48 hours. Parental antibiotics were given for two days followed by oral antibiotics for one more week. Pin sites were regularly inspected and Betadine dressings given.

Patients were discharged by fifth day and reviewed every week till six weeks. On every visit, extent of finger movements was noted. Pin site was examined for infection.

At six weeks after confirming union, external fixator was removed and sterile dressing and elastocrepe bandage applied. A radiograph was also taken.

Active wrist mobilization was started. Patients were reviewed on three months of treatment. Every time functional and radiological assessment were made and compared to the normal side.



SIX PACK EXERCISES

ANALYSIS OF RESULTS

ANALYSIS OF RESULTS

The results of this study were analyzed using the patient evaluation and subjective rating scheme. This system was introduced by Gartland & Werley in 1951 and modified by Sarmiento. This is a functional demerit system and allow for comparison of results among several studies and also different methods of fixation.

Bony union was achieved in all patients. DRUJ pain occurred in 2 patients and DRUJ instability in 3 patients. At the end of 3 months patient were evaluated using the Gartland & Werley's system as follows.

It consists of

Subjective Evaluation	0- 6 points
Objective Evaluation	0 – 3 points
Residual Deformity	0 – 5 points
Complications	0 – 5 points
Final Result	Total

A. SUBJECTIVE EVALUATION

Excellent	No pain, disability or limitation of motion	0
Good	Occasional pain, slight limitation of motion, no disability	2
Fair	Occasional pain, some limitation of motion, feeling of weakness in wrist, no specific disability if careful, and activities lightly restricted	4
Poor	Pain, limitation of motion, disability, activities more or less markedly restricted	6

B. OBJECTIVE EVALUATION

Loss of Dorsiflexion	5
Loss of ulnar deviation	3
Loss of supination	2
Loss of palmar flexion	1
Loss of radial deviation	1
Pain in distal radio ulnar joint	1
Grip strength less than 60% of opposite side	1
Loss of pronation	2

C. RESIDUAL DEFORMITY

Prominent ulnar styloid	1
Residual dorsal tilt	2
Radial deviation of hand	2or 3

D. COMPLICATONS

ARTHRITIC CHANGE	
Minimum	1
Minimum with pain	3
Moderate	2
Moderate with pain	4
Severe	3
Severe with pain	5
Nerve complications	1 – 3
Poor finger function	1 – 2

FINAL RESULT

Excellent	0-2
Good	3 – 8
Fair	9- 20
Poor	>21

In our study, according to the system out of 20 wrists treated the results were as follows

EXCELLENT	**3**
GOOD	**8**
FAIR	**7**
POOR	**2**

The results of the procedure were analysed radiographically and clinically at 3 months postoperatively. Three patients had superficial pintract infections which were treated with antibiotics and pintract care. All subsided without sequalae.

In five cases the fragments are displaced even after ligamentotaxis, so it is augmented with K wire fixation in those cases.

In One case with metaphyseal comminution removal of external fixator at 6 weeks resulted in metaphyseal collapse resulting in reduced radial length. This indicated the need for keeping the fixator for longer time in cases of metaphyseal comminution with risk of late metaphyseal collapse.

One patient developed radial sensory nerve deficit which recovered after 3 months.

We did not encounter iatrogenic fracture of the metaphyseal due to pin insertion which is reported in literature, this probably reflects need for careful predrilling and using drilling template. In case of compound injuries also external fixators allowed excellent access for wound care

This study also provided a chance to analyse the Frykman's Classification. Frykman's classification proved to be descriptive but not predictive. Even in cases of Frykman's VII and VIII injuries excellent results (3) and good results were obtained, provided the injuries were due to low velocity violence.

The results of high energy injuries were modest probably because of the associated soft tissue and ligamentous injury.

The Frykman's classification also does not account for distal ulna fractures which were associated in three of our patients. The AO – ASIF classification includes distal ulna fractures and hence appears comprehensive.

Thus identification of soft tissue injury and high velocity injuries may prove to be useful in the management. This recognition led us to use an additional support in the form of palmar (volar) slab for the first few days to few weeks in case of high velocity injuries indicated by mode of injury and gross swelling.

CASE ILLUSTRATIONS

CASE ILLUSTRATIONS

CASE 1 CHITRA

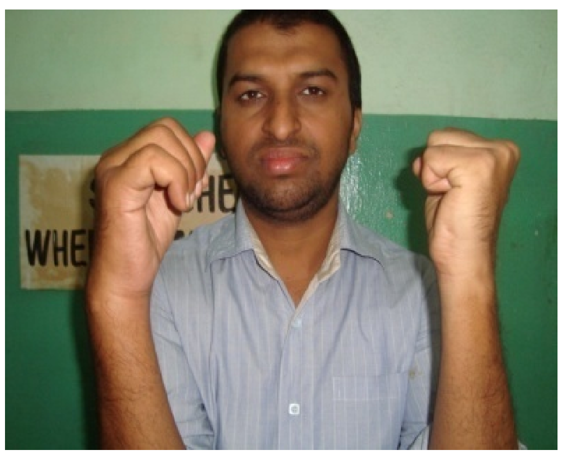
CASE -1

CASE 2 SHARATH

CASE 2 SHARATH

CASE - 3: SHYAM

CASE -3



CASE 4 : STEPHEN

CASE :4

CASE 5 :SELVI

DISCUSSION

DISCUSSION

Paul A. Vaughan et al in their study on unstable distal radius fracture treated by external fixation obtained 29% excellent and 60% good result. Restoration of normal anatomy is important for restoration of function. Normally 82% of the compressive load across the

Wrist is borne by distal radius and remaining by distal ulna. With 2.5mm loss of radial length, ulna bears 42% load and at 20 degree dorsal angulation, ulna bears 50% load.

Preservation of radial length is the most important factor for preservation of function. Loss of radial length can lead to ulnar impaction or dysfunction of Distal Radio Ulnar Joint, with limited range of motion in pronation and supination, depending on the volar or dorsal subluxation of the ulnar head within the sigmoid notch.

The main shortening of the method is its inability to maintain volar tilt and in cases of overdistraction it produced a dorsal tilt. Since the fracture occurs in cancellous region, the distraction causes a gap at the fracture which occurs due to fracture impaction.

So, in cases with metaphyseal comminution the fracture actually takes long time to consolidate. So in cases with metaphyseal comminution, the external fixator has to be kept for a longer time or there should be addition of cancellolus bone graft to avoid metaphyseal collapse.Residual dorsal angulation can precipitate ulnar impaction, midcarpal instability and altered stress concentration which may lead to early arthritis. Porter, in his study, felt that loss of function did not occur until at least 20 degrees of palmar tilt was lost.

In ligamentotaxis with external fixation, radial length, ulnar variance and radial angulation are restored to normal but correction of volar tilt though adequate, is not complete.

This is attributed to the fact that volar ligaments are stronger and become taut on distraction before the dorsal ligaments which are in a relative ‘Z’ orientation. So, on distraction, palmar cortex is brought out to length before dorsal cortex preventing full correction of dorsal tilt

The external fixator was also unable to correct the depressed lunate fossa(as pointed out by Melone)[29], which may need additional procedures like pinning and elevation of the depressed fragment.

The ulnar styloid fractures with displacements > 3 mm indicates higher degrees of fracture displacements and injury to triangular fibrocartilage & it needs to be fixed.

Higher velocity injuries yield poor results. This reiterates the role of soft tissue and ligaments in fracture healing. So, the addition of palmar plaster splint (as advocated by Fernandez and Palmer) was effective in giving rest to soft tissues and also supportive in unstable fracture patterns.

We encountered DRUJ pain in 3 patients and DRUJ instability in 2 patients. It might have been useful to have cross-pinned the ulna to radius in supination.

CONCLUSION

CONCLUSION

Fractures of the distal radius though common and appear simple, affect the function of the wrist considerably. It is the commonest fracture seen in the outpatient department and most are treated with plaster immobilization. Most of these fractures are unstable resulting in loss of reduction and hence malunion, altered wrist kinematics, poor range of motion and early arthritis.

The external fixation and ligamentotaxis proved to be a very useful method for treating unstable distal radius fracture. Though an effective method, it is not a panacea for all the injuries as different patterns of injuries emerge due to increased accidents and high velocity injuries.

Our study equalled previous studies on external fixation for unstable distal radius fractures in results, showing simplicity and superiority of ligamentotaxis with external fixation for the. management of these fractures

Thus the distal radius fracture is no longer a simple fracture to treat by cast alone and more aggressive treatment is needed to restore the articular congruity and functional outcome.

In this study we found that the frame we used cost-effective , easy to apply, tolerated well by the patients and gives access to wound care. We conclude that external fixation and ligamentotaxis applied to complex distal radius fractures, when added with augmented K-wire fixation and bone grafting can provide direct augmentation of fracture stablility and a good wrist function. The successful treatment of comminuted intra- articular fractures of distal radius is dependent upon the surgeon’s ability to restore articular congruity.

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BIBILOGRAPHY

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PROFORMA

Consent Proforma

Aim:

The aim is to study the functional outcome of unstable distal radius fractures managed by ligamentotaxis with external fixation

Consent:

I have been explained about the nature of my injury, methods of treatment, potential complications and need of regular follow up visits in my own vernacular language.

I hereby give my consent for including me in the study.

CLINICAL PROFORMA

1. Name

2. Age

3. Sex

4. In-Patient no.

5. Mode of injury

6. Side of injury

7. Dominant side

8. AO type

9. Associated injury

10. Associated compliations

11. Date of injury

12. Date of surgery

13. Date of fixator removal

14. Post operative radiology
    Radial length –
    Volar tilt –
    Radial angulation -
    Ulnar variance –

16. Pin site infection

17. Pin site loosening

THREE MONTHS:

18. Stiffness

19. Pain

20. Functional status

21. Median nerve deficit

22. Radial sensory nerve deficit

23. Tendon rupture

24.

MOVEMENT	ROM
Palmar flexion	
Dorsi flexion	
Radial deviation	
Ulnar deviation	
Supination	
Pronation	

25.

	FINDINGS
Radial length	
Volar tilt	
Radial angulation	
Ulnar variance	

26. Grip strength - (% 0f opposite side)

27.Gartland and Werley demerit score:

28.RESULT: Excellent / Good / Fair / Poor.

MASTER CHART

case No.	NAME	AGE / SEX	MODE OF INJURY	FRYKMAN'S TYPE	PAIN AT 3 MONTH	RANGE OF MOVEMENTS						VOLAR TILT	RADIAL INCLINATION	RADIAL LENGTH	ASSOCIATED INJURIES	COMPLICATIONS	FINGER MOVEMENTS	GRIP STRENGTH	RESULT
						P F	D F	U D	R D	S U P	P R O								
1	CHITHRA	26/F	RTA	VIII	NILL	70	60	25	15	60	60	0	20	7	NIL	NIL	G	G	G
2	RAJAM	29 / F	RTA	VIII	MOD	60	50	15	10	45	45	0	12	5	# DISTAL ULNA	PTI	F	F	F
3	SHARATH	25 / M	RTA	VIII	NILL	60	60	20	15	70	70	0	20	9	NIL	NIL	G	G	G
4	ELANGO	42 / M	RTA	VII	NILL	80	80	20	15	90	90	5	2	9	NIL	PTI	G	G	G
5	SELVI	35 /F	RTA	VII	NILL	70	70	20	10	80	90	8	24	4	NIL	NIL	G	G	G
6	MEENAMAL	48/ F	FALL	VI	NILL	70	60	15	10	55	45	-4	20	5	NIL	NIL	G	G	G
7	STEPHEN	26 / M	RTA	III	NILL	60	40	15	10	40	45	-6	18	5	NIL	NIL	G	F	F
8	SHYAM	23 / M	RTA	III	NILL	60	50	15	10	50	60	-4	17	4	NIL	NIL	G	F	F
9	MUTHAMMAL	62 / F	FALL	V	NILL	60	40	20	10	70	80	-4	20	5	NIL	NIL	G	F	F
10	MUNUSAMY	51 / M	FALL	VII	NILL	70	80	20	15	90	90	0	20	8	NIL	NIL	G	G	G
11	VIMALA	53 / F	FALL	VIII	NILL	80	80	30	20	90	90	5	20	9	NIL	NIL	G	G	E
12	VASU DEVAN	57 / M	FALL	IV	NILL	70	60	25	15	80	90	-2	22	10	NIL	NIL	G	G	G
13	ANNAMAL	65 / F	FALL	VII	MOD	45	45	20	10	70	70	2	15	5	NIL	NIL	G	G	F
14	RAJESHWARI	43 / F	FALL	VII	NILL	80	80	35	20	90	90	6	18	8	NIL	NIL	G	G	E
15	ANJALAI	55 / F	FALL	VIII	MOD	60	60	15	15	70	70	0	20	9	NIL	DRUJ PAIN	G	F	F

16	RENUKA	44 / F	RTA	VIII	SEV	20	20	10	10	55	45	0	8	6	# DISTAL ULNA	PTI	P	P	P
17	DEVI	41 / F	RTA	VI	MOD	40	30	15	10	45	40	0	10	4	NIL	DRUJ INSTABILITY	P	P	P
18	VANIAMMAL	64 / F	FALL	VIII	NILL	70	70	25	10	70	70	2	18	7	NIL	NIL	G	G	G
19	DINESH	44 / M	RTA	II	NILL	80	80	25	20	90	90	6	20	10	NIL	PTI	G	G	E
20	MARUTHAI	65 / M	FALL	II	MOD	70	60	25	15	60	60	0	20	7	NIL	DRUJ PAIN	F	F	G

FUNCTIONAL SCORE

case No.	NAME	AGE / SEX	FRYKMAN'S TYPE	SUBJECTIVE EVALUATION (0 -6)	OBJECTIVE EVALUATION LOSS OF / OR									DEFORMITY 0 - 3			COMPLICATIONS			TOTAL	CATEGORY
					D F 0 - 5	U D 3	S U P 2	P F 1	R D 1	C D 1	DRUJ PAIN 1	GRIP STRENGTH 1	PRO 2	PROMINENT UL . STYLOID 1	RES.DORSAL TILT 1-2	RADIAL DEVIATION 3	ARTHRITIS	NERVE INJURIES	FINGER FUNCTION		
1	CHITHRA	26/F	VIII	0	5	0	1	1	0	0	0	0	0	0	0	0	0	0	0	7	G
2	RAJAM	29 / F	VIII	2	3	0	2	1	0	1	1	2	0	0	0	0	0	0	1	13	F
3	SHARATH	25/ M	VIII	0	3	0	2	1	1	0	0	1	0	0	0	0	0	0	0	8	G
4	ELANGO	42 / M	VII	0	0	3	2	0	0	0	0	1	0	0	0	0	0	0	0	6	G
5	SELVI	35 /F	VII	0	0	3	0	0	1	0	0	0	2	0	0	1	0	0	0	7	G
6	MEENAMAL	48/ F	VI	2	3	3	2	1	0	0	0	0	2	0	2	0	0	0	0	15	F
7	STEPHEN	26 / M	III	2	5	2	2	1	0	0	0	1	2	0	2	0	0	0	0	16	F
8	SHYAM	23 / M	III	2	5	3	2	1	0	0	0	1	2	0	2	0	0	0	0	18	F
9	MUTHAMMAL	62 / F	V	2	5	0	1	1	0	0	0	1	0	0	2	0	0	0	0	12	F
10	MUNUSAMY	51 / M	VII	0	0	3	0	0	0	0	0	1	2	0	0	0	0	0	0	6	G

11	VIMALA	53 / F	VIII	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	2	E
12	VASU DEVAN	57 / M	IV	0	5	0	0	0	1	0	1	0	0	0	1	0	0	0	0	7	G
13	ANNAMAL	65 / F	VII	2	5	3	2	0	0	0	0	2	0	1	0	0	0	0	0	15	F
14	RAJESHWARI	43 / F	VII	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	E
15	ANJALAI	55 / F	VIII	2	3	3	2	1	1	1	0	1	2	0	0	0	1	0	0	15	F
16	RENUKA	44 / F	VIII	4	5	3	2	1	1	1	1	1	2	0	2	0	4	0	2	29	P
17	DEVI	41 / F	VI	4	5	3	2	1	1	1	1	1	2	0	2	0	4	0	2	29	P
18	VANIAMMAL	64 / F	VIII	0	3	3	0	0	0	0	0	0	0	0	0	2	0	0	0	8	G
19	DINESH	44 / M	II	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	E
20	MARUTHAI	65 / M	II	0	5	0	1	1	0	0	0	0	0	0	0	0	0	0	0	7	G

DF	Dorsiflexion
PF	Palmarflexion
SUP	Supination
PRO	Pronation
UD	Ulnar deviation
RD	Radial deviation
CD	circumduction
E	Excellent
G	Good
F	Fair